

A SALUTE TO SIR JOHN BURDON-SANDERSON AND MR. CHARLES DARWIN
ON THE CENTENNIAL OF THE DISCOVERY OF
NERVE-LIKE ACTIVITY IN THE VENUS' FLYTRAP

By Stephen E. Williams

In the year 1873 Charles Darwin was deeply involved with the study of carnivorous plants that was to culminate with his publication of his book, Insectivorous Plants, in 1875. He had a number of discussions with his friend and fellow member of the Royal Society, John Burdon-Sanderson about the possibility that excitable cells of plants such as Drosera (Sundew) and Dionaea (Venus' flytrap) might exhibit phenomena similar to those present in excitable animal tissues such as nerve. Burdon-Sanderson's diary was filled with references about his communications with Darwin on the subject during this period.

On September 9, 1873 the two passed the conversational stage when Darwin sent Burdon-Sanderson the following letter:

"I will send up early tomorrow two plants [of Dionaea] with five goodish leaves, which you will know by their being tied to sticks. Please remember that the slightest touch, even by a hair, of the three filaments on each lobe makes the leaf close and it will not open for twenty-four hours. You had better put 1/4 in. of water into the saucers of the pots. The plants have been kept cool in order to retard them. You had better keep them rather warm (i.e., temperature of warm greenhouse) for a day, and in a good light.

"I am extremely glad you have undertaken this subject. If you get a positive result, I should think you ought to publish it separately, and I could quote it; or I should be most glad to introduce any note by you into my account.

"I have no idea whether it is troublesome to try with the thermo-electric pile any change of temperature when the leaf closes. I could detect none with a common thermometer. But if there is any chance of temperature I should expect it would occur some eight to twelve or twenty-four hours after the leaf has been given a big smashed fly, and when it is copiously secreting its acid digestive fluid.

"I forgot to say that, as far as I can make out, the inferior surface of the leaf is always in a state of tension, and that the contraction is confined to the upper surface; so that when this contraction ceases or suddenly fails (as by immersion in boiling water) the leaf opens again, or more widely than is natural to it.

"Whenever you have quite finished, I will send for the plants in their basket. My son, Frank, is staying at 6, Queen Ann Street, and comes home on Saturday afternoon, but you will not have finished by that time."

Burdon-Sanderson, who was to become a Professor at Oxford Medical School and the leading British physiologist of his day, must have been very excited by his results for when he deemed them satisfactory - on September 12, 1873 - he immediately telegraphed Darwin at his country home* to tell his findings. Unfortunately, the telegram has apparently been lost. However, we can gain some understanding of it by reading Darwin's letter of reply which was sent on September 13, 1873.

"How very kind it was of you to telegraph to me. I am quite delighted that you have got a decided result. Is it not a very remarkable fact? It seems so to me, in my ignorance. I wish I could remember more distinctly what I formerly read of Du Bois Raymond's [sic.] results. [Du Bois-Reymond discovered that electrical impulses carry messages in nerves.] My poor memory never serves me for more than a vague guide. I really think you ought to try Drosera." **

This was the first detection of nerve-like activity in any plant. Excitable plant cells and excitable animal cells were shown to have similar properties. Burdon-Sanderson went on to do numerous elegant experiments on Dionaea and it is from him we learned most of what we know about the physiology of its rapid movements.

Burdon-Sanderson used the most modern techniques of his time in his studies. His methods were superior to those used as late as 1930 in investigations of Dionaea. With the exception of one minor drawing of a trigger hair,*** which was most likely not done by him, I have never found any of his data to be in error. His work still provides the major body of knowledge about the nerve-like activity and the rapid movements of Dionaea and it should not be ignored by those who wish to study these phenomena.

On the following page is a bibliography of Burdon-Sanderson's papers on Dionaea. It is possible that I have overlooked a few publications and that a thorough search of journals such as Nature would reveal more papers published by him on the subject. However, this bibliography is the most complete list of Burdon-Sanderson's work on Dionaea that I know of and it should be of use to anyone interested in the excitability of the Venus' flytrap.

* Efforts to locate the telegram at Kew, Down House (Darwin's home), Oxford and Cambridge have all failed. If anyone knows of it or its contents I hope he will publish it in the Newsletter.

** Unfortunately, Burdon-Sanderson did not "try Drosera" but Darwin's suggestion was carried out at Washington University in St. Louis during March 1968 (although we did not know he had suggested it at the time) and nerve-like activity has been discovered in that genus of plants as well (See Williams and Pickard, Planta 103, 193, 1972).

*** In paper number 12.

Burdon-Sanderson on *Dionaea*

A Bibliography

1. Burdon-Sanderson, J.: Note on the electrical phenomena which accompany stimulation of the leaf of *Dionaea muscipula*. Proc. roy. Soc. 21, 495-496 (1873).
2. Burdon-Sanderson, J.: Venus' flytrap (*Dionaea muscipula*), I. Nature 10, 105-107 (1874).
3. Burdon-Sanderson, J.: Venus's flytrap (*Dionaea muscipula*), II. Nature 10, 127-128 (1874).
4. Burdon-Sanderson, J., Page. F. J.M. : On the mechanical effects and on the electrical disturbance consequent on excitation of the leaf of *Dionaea muscipula*. Proc. roy. Soc. 25, 411-434 (1876).
5. Burdon-Sanderson, J.: On the electromotive properties of the leaf of *Dionaea* in the excited and unexcited states, I. Proc. roy. Soc. 23, 148-151 (1881).
6. Burdon-Sanderson, J.: On the electromotive properties of *Dionaea* in the excited and unexcited states. Phil. Trans. 173, 1-53 (1882).
- 7.* Burdon-Sanderson, J.: Die elektrischen Erscheinungen am *Dionaea*blatt. Biol. Zentralbl. 2, 481-500 (1882).
8. Burdon-Sanderson, J.: On the electromotive properties of the leaf of *Dionaea* in the excited and unexcited states, II. Proc. roy. Soc. 44, 202-204 (1888).
9. Burdon-Sanderson, J.: On the electromotive properties of the leaf of *Dionaea* in the excited and unexcited states. Phil. Trans. B 179, 417-449 (1888).
- 10.* Burdon-Sanderson, J.: Die elektrischen Erscheinungen am *Dionaea*-Blatt (zweite Mitteilung). Biol. Zentralbl, 9, 1-14 (1889).
11. Burdon-Sanderson, J.: Croonian Lecture--On the relation of motion in animals and plants to the electrical phenomena which are associated with it. Proc. roy. Soc. 65, 37-64 (1899).
- 12.** Burdon-Sanderson, J.: The excitability of plants. In: Sir John Burdon-Sanderson, a memoir..with a selection from his papers and addresses, p. 172-198 (Burdon-Sanderson, G., et. al., eds.) Oxford: Clarendon Press 1911.

* At the time these articles were written "Biol. Zentralbl." was spelled "Biol. Centralbl."

** A paper delivered before the Royal Society on June 9, 1882 and published posthumously in Burdon-Sanderson's biography.